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ELECTRONIC COMPONENT

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[There are no amendments to this patent.]

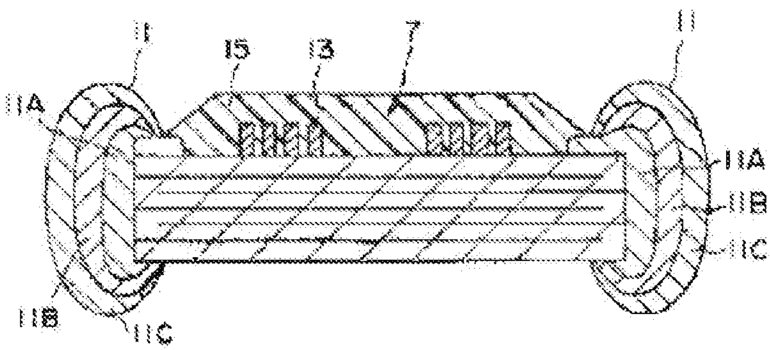
Abstract

Problem

To provide a composite electronic component that has both a large-capacitance capacitive element and an inductor with good L value precision, and that is small and inexpensive.

Means to solve

A thick-film laminate 5, on which a desired conductive pattern 2 of silver palladium is formed on a ferroelectric ceramic substrate 1A to form a capacitive element 3, is fired. Then a thin-film coil part 7 is additionally furnished on top, and terminal electrodes 11 and 11 are formed at both ends of a chip. Thin-film coil part 7 has a constitution wherein a thin-film coil 13 formed in a circumferential form and an insulating resin layer 15 of a benzocyclobutene resin are laminated.



Claims

1. An electronic component characterized by the fact that, after a thick-film laminate, wherein a ferroelectric and a conductor are laminated to form at least one capacitive element in the interior is fired, an inductor wherein a conductor pattern and an insulating resin are laminated is furnished on the aforementioned thick-film laminate, and said inductor is electrically connected to the aforementioned capacitive element.

2. An electronic component characterized by the fact that, in the electronic component described in Claim 1, a benzocyclobutene resin is used for the aforementioned insulating resin.

3. An electronic component characterized by the fact that, in the electronic component described in Claim 1, a terminal electrode formed to be connected to part of the aforementioned conductor pattern is additionally provided, and said terminal electrode is electrically connected to the aforementioned capacitive element.

4. An electronic component characterized by the fact that, in the electronic component described in Claim 3, the aforementioned terminal electrode has a foundation electrode and a surface electrode covering said foundation electrode, and the aforementioned surface electrode has a Ni film and a noble metal film formed on the aforementioned Ni film.

5. An electronic component characterized by the fact that after a magnetic material and a conductor are laminated and at least one inductor is formed in the interior and fired, a capacitive element wherein a conductor pattern and a dielectric layer are laminated is furnished on the

aforementioned thick-film laminate, and said capacitive element is electrically connected to said inductor.

6. An electronic component characterized by the fact that, in the electronic component described in Claim 5, a benzocyclobutene resin is used for the aforementioned conductor layer.

7. An electronic component characterized by the fact that, in the electronic component described in Claim 5, a terminal electrode formed to be connected to part of the aforementioned conductor pattern is additionally provided, and said terminal electrode is electrically connected to the aforementioned inductor.

8. An electronic component characterized by the fact that, in the electronic component described in Claim 7, the aforementioned terminal electrode has a foundation electrode electrically connected to the aforementioned conductor pattern and a surface electrode covering said foundation electrode, and the aforementioned surface electrode has a Ni film and a noble metal film formed on the aforementioned Ni film.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention relates to an electronic component, and more specifically, relates to a composite electronic component wherein inductor (L) and capacitor (C) elements are constituted on the same component.

[0002]

Prior art

The use of a thick-film laminated structure is known as an example of such a conventional composite electronic component.

[0003]

In short, with such conventional composite electronic components, as shown in Figure 9 for example, a process to form a desired conductive pattern 72 of silver palladium (AgPd) on a ferroelectric (strong ε) ceramic substrate 71A using screen printing is repeated to form capacitive element 73. Thick-film laminate 77, on which inductor 75 is formed by repeating a process to additionally form a circumferential conductive pattern 74 of AgPd on top of ferroelectric ceramic substrate 71B in the same way using screen printing, is fired. Then Ni layers 81 and 81 are formed using electroless plating on printed Ag layers 79 and 79 made by applying and printing silver (Ag) paste at both ends of thick-film laminate 77, and solder layers 83 and 83 are additionally formed on the top layer to constitute terminal electrodes 85 and 85.

[0004]

With other conventional composite electronic components, as shown in Figure 10 for example, integrally furnished are a first thick-film laminate 89, on which capacitance element 73 is formed by repeating a process to form a desired conductive pattern 72 of silver palladium (AgPd) on a ferroelectric ceramic substrate 87 using screen printing, and a second thick-film laminate 95, on which inductor 93 is formed by repeating a process to additionally form a circumferential conductive pattern 92 of AgPd on top of a nonmagnetic, non-ferroelectric ceramic substrate 91, such as a low-temperature glass alumina ceramic. After first and second thick-film laminates 89 and 95 are fired, printed Ag layers 79 and 79, Ni layers 81 and 81, and solder layers 83 and 83 are formed to constitute terminal electrodes 85 and 85 just as in the conventional example in Figure 9 described above.

[0005]

Problems to be solved by the invention

However, with a composite electronic component using a thick-film laminate structure as shown in Figure 9 wherein the capacitive element and inductor are embedded inside a ferroelectric ceramic, while a large-capacitance capacitor is obtained, the formation of a precision coil pattern is difficult, so forming an inductor with a highly-precise reactance is difficult. That is, the coefficient of contraction after thick-film laminate 77 is fired differs from that of ferroelectric ceramic substrate 71A and circumferential conductive pattern 74 of AgPd, so misalignment occurs in the printed coil pattern in conjunction with the problem of the screen mesh stretching in the screen printing process, with the problem that the desired reactance precision is not produced. Also, because misalignment occurs in the printed pattern, there are also problems in terms of capacitance precision, and with attempts to achieve precision, relative positioning of ferroelectric substrate 71A on which conductive pattern 72 of AgPd is formed is difficult, and complexity in the manufacturing process is unavoidable.

[0006]

In addition, when not only a capacitive element, but also an inductor (coil) is produced in a ferroelectric ceramic, there is a problem of floating capacitance.

[0007]

With the composite electronic component shown in Figure 10, an inductor (coil) is formed in a nonmagnetic, non-ferroelectric ceramic such as a low-temperature glass alumina ceramic, so the problem of floating capacitance as described above can be reduced, but achieving reactance precision is still difficult due to problems with the coefficient of contraction after firing and stretching of the screen mesh. Complexity in positioning to achieve capacitance precision is also unavoidable. In addition, because low-temperature glass alumina ceramic is expensive, it has been difficult to obtain inexpensive composite electronic components.

[0008]

So the technical problem of the present invention is to provide a composite electronic component that can be thinner, as well as being small and inexpensive.

[0009]

Another technical problem of the present invention is to provide a composite electronic component that has both a large-capacitance capacitive element and an inductor with high L value precision, and that is small and inexpensive.

[0010]

Still another technical problem of the present invention is to provide a composite electronic component that is small and inexpensive, and that includes an inductor that has a relatively large L value.

[0011]

Means to solve the problems

With the present invention, an electronic component is obtained that is characterized by the fact that a thick-film laminate, wherein a ferroelectric and a conductor are laminated to form at least one capacitive element in the interior, is fired, then an inductor wherein a conductor pattern and an insulating resin are laminated is furnished on the aforementioned thick-film laminate, and said inductor is electrically connected to the aforementioned capacitive element.

[0012]

Also, with this invention, an electronic component is obtained that is characterized by the fact that a benzocyclobutene resin is used for the aforementioned insulating resin.

[0013]

Also, with this invention, an electronic component is obtained that is characterized by the fact that a terminal electrode is additionally formed to be electrically connected to part of the aforementioned conductor pattern, and said terminal electrode is electrically connected to the aforementioned capacitive element.

[0014]

Also, with the present invention, an electronic component is obtained that is characterized by the fact that the aforementioned terminal electrode has a foundation electrode electrically connected to the aforementioned conductor pattern and a surface electrode covering said foundation electrode, and the aforementioned surface electrode has a Ni film and a noble metal film formed on the aforementioned Ni film.

[0015]

In addition, with the present invention, an electronic component is obtained that is characterized by the fact that at least one inductor is formed in the interior by laminating a magnetic material and a conductor, and is fired, and then a capacitive element is furnished wherein a conductor pattern and a dielectric layer are laminated on the aforementioned thick-film laminate, and said capacitive element is electrically connected to the aforementioned inductor.

[0016]

Also, with the present invention, an electronic component is obtained that is characterized by the fact that a benzocyclobutene resin is used for the aforementioned conductor layer.

[0017]

Also, with the present invention, an electronic component is obtained that is characterized by the fact that a terminal electrode formed to be electrically connected to part of the aforementioned conductor pattern is additionally provided, and said terminal electrode is electrically connected to the aforementioned inductor.

[0018]

Also, with the present invention, an electronic component is obtained that is characterized by the fact that the aforementioned terminal electrode has a foundation electrode electrically connected to the aforementioned conductor pattern and a surface electrode covering said foundation electrode, and the aforementioned surface electrode has a Ni film and a noble metal film formed on the aforementioned Ni film.

[0019]

Embodiment of the invention

Embodiments of the present invention will be explained below referring to figures.

[0020]

Figure 1 is a cross section showing the schematic constitution of a composite electronic component based on a first embodiment of the present invention. Referring to Figure 1, with the composite electronic component pertaining to this embodiment, thick-film laminate 5, on which capacitance element 3 is formed by repeating a process to form a desired conductive pattern 2 of silver palladium (AgPd) on ferroelectric (high ε) ceramic substrate 1A using screen printing, is fired. Then a thin-film coil part 7 is additionally furnished on top of that, and terminal electrodes 11 and 11 are formed at both ends of the chip that is coated with a heat-resistant resin 9.

[0021]

Figure 2 is a cross section schematically showing the constitution of the composite electronic component shown in Figure 1.

[0022]

Thin-film coil part 7, as shown in Figure 2, has a constitution wherein a thin-film coil 13 formed in a circumferential form using a coil conductor of Cu and an insulating resin layer 15 of polyimide are laminated. As for terminal electrodes 11 and 11, Ni layers 11B and 11B are also furnished using plating on terminal foundation electrodes 11A and 11A formed by sputtering Ag, and solder layers 11C and 11C are additionally formed.

[0023]

With the composite electronic component pertaining to this embodiment, in addition to obtaining a large-capacitance capacitive element, a precision coil pattern for thin-film coil part 7 can be formed, so an inductor with high reactance precision is also obtained. Only capacitive element 3 is produced in the ferroelectric ceramic, and thin-film coil 13 is furnished for thin-film coil part 7 with a constitution wherein it is laminated with insulating resin layer 15 of polyimide, so the problem of floating capacitance that occurs in the conventional composite electronic component shown in Figure 8 does not occur.

[0024]

Therefore, a composite electronic component can be provided that has both a high-capacitance capacitive element and an inductor with a high-precision L value, as well as being small and inexpensive.

[0025]

Here, with the above embodiment, while thin-film coil 13 was furnished for thin-film coil part 7, a resistor layer could of course also be furnished in addition to the inductor.

[0026]

Next, a composite electronic component pertaining to a second embodiment of the present invention will be explained referring to figures.

[0027]

The basic constitution of the composite electronic component pertaining to the second embodiment is approximately the same as that of the first embodiment shown in Figure 1. With the composite electronic component in the second embodiment, the significant distinction is that benzocyclobutene (BCB) resin is used for insulating resin layer 15 of thin-film coil part 7.

[0028]

And in place of terminal electrodes 11 and 11 in the first embodiment shown in Figure 1, a terminal electrode using a conductive resin and a plated electrode are used.

[0029]

Here, first, the construction method for thin-film coil part 7 in the second embodiment will be explained.

[0030]

Figures 3 and 4 show the process of forming conductive pattern 12, which is a Cu conductor layer, of thin-film coil part 7 in the second embodiment.

[0031]

Referring to Figure 3, first, as shown in Figure 3(a), after BCB resin layer 42a is hardened with ultraviolet rays, it is degreased and washed, and then a first etching and a second etching are applied, with washing in between. After washing with clear water, and after a catalyst is supplied, washing with pure water is performed twice, followed by immersion in an electroless Cu plating bath. The electroless Cu plating bath uses a composition of 125 mL/L of copper ion replenisher (MCU-AHS) made by World Metal, 125 mL/L of a reducing and complexing agent (MCU-BHS) and 700 mL/L of pure water. Electroless Cu plating was followed by washing with pure water and oxide removal, and further washing with pure water was followed by washing with alcohol and drying.

[0032]

Figure 3(b) shows an insulation layer where electroless Cu-plated layer 43 is formed on one surface. In Figure 3(b), the electroless Cu-plated layer 43 is 1 μm thick.

[0033]

Next, after resist 54 was applied as shown in Figure 3(c), photolithography as shown in Figure 3(d) was used for exposure and developing through mask 55, and resist pattern 54' shown in Figure 4(a) was obtained.

[0034]

Next, as shown in Figure 4(b), electrolytic Cu-plated layer 56 was obtained using electrolytic Cu plating. The electrolytic Cu plating was performed after surface treatment. Next, resist pattern 54' was removed and a full conductive pattern 57 as shown in Figure 4(c) was obtained.

[0035]

Next, the exposed portion of electroless Cu-plated layer 43 in full conductive pattern 57 shown in Figure 4(c) was removed with wet etching and washing with HCl, and an isolated pattern 63 formed on insulation layer 42a was obtained as shown in Figure 4(d). Here, while the surface of electrolytic Cu-plated layer 56 is also slightly etched by the etching, because it is thicker than electroless Cu-plated layer 43', the conductor pattern is not lost.

[0036]

Conductor pattern 63 that is obtained comprises the pattern of electroless Cu-plated layer 43' and the pattern of electrolytic Cu-plated layer 56, and is about 3-5 μm thick and about 30 μm wide. No problems occurred during the production process in the washing, photolithography, etching or washing processes.

[0037]

Figure 5 shows the process for forming insulating resin layer 15 of thin-film coil part 7 shown in Figure 1. Referring to Figure 5, a BCB resin that is hardened with ultraviolet rays was applied using spin coating, as shown in Figure 5(a), to cover conductor pattern 63 formed on insulating layer 42a shown in Figure 4(d), and insulating layer 58 was obtained. Next, as shown in Figure 5(b), photolithography was used, exposure was performed through mask 59, and through-holes 61 were formed in insulating layer 58 as shown in Figure 5(c). Here, through-holes 61 are for obtaining electrical contact with the conductor formed on the top part of insulating layer 58, and are not necessarily formed on all of conductor pattern 63.

[0038]

Next, insulating layer 62b shown in Figure 5(d) was obtained by partial curing at 210°C for 30 min in a nitrogen atmosphere.

[0039]

With the composite electronic component pertaining to this embodiment, because BCB resin is used for insulating resin layer 15 of thin-film coil part 7, smoothing of unevenness in the conductive pattern produced by the insulating resin film is extremely good, and as a result, there is no rippling in the conductive pattern laminated on top, and a conductive pattern with high dimensional precision can be formed. And because there is no rippling in the conductive pattern, thin-film coil part 7 can be made even thinner by that amount, compared to the first embodiment above. In addition, because a conductive pattern with high dimensional precision and with no rippling in the conductive pattern can be formed, an inductance with high precision of the L value can also be furnished for thin-film coil part 7.

[0040]

In addition, because BCB resin, with which there is no concern over Cu migration, is used, a Cu pattern that has low resistance, that can be electrolytically plated, and with which wet etching is also easy, can be selected for the conductive pattern, and a low-cost composite electronic component can be provided.

[0041]

Next, the constitution of the terminal electrodes in a second embodiment will be explained using Figure 6.

[0042]

Terminal electrodes 38 and 38 (only one is shown in Figure 6) have a foundation electrode electrically connected to conductor pattern 2 in insulating substrate 10 of glass epoxy or the like, and a surface electrode covering the foundation electrode. The surface electrode has an electroless Ni plated film and a noble metal film formed thereon.

[0043]

That is, referring to Figure 6, wiring terminal part 40 of conductor pattern 2 is formed on insulating substrate 10, and wiring terminal part 40 is formed laminated alternately with insulating layer 42 of an insulating resin and conductor pattern 43 of a conductor. In terminal electrode 38, electrode part 44 is formed on the top end of wiring terminal part 40, which is composed of a laminate, and foundation electrode 45 of a conductive resin is formed from the conductive resin so as to cover the end part of the underside of terminal part 40, including a part of electrode part 44. In addition, electroless Ni plated film 46 is formed to cover electrode part 44 and foundation electrode 45, and electroless palladium plated film 47 is additionally formed to cover that.

[0044]

Here, foundation electrode 45 is made by mixing a conductive metal powder into a resin, applying, and hardening.

[0045]

In the composite electronic component obtained in the second embodiment, the same reliability as with the prior art is obtained with no peeling away of terminal electrodes 38 and 38.

[0046]

With the second embodiment, no solder is used in the portion with terminal electrodes 38 and 38, so waste treatment of Pb and the like is not necessary, and problems of environmental pollution do not occur.

[0047]

Next, a composite electronic component pertaining to a third embodiment of the present invention will be explained.

[0048]

Figure 7 is a cross section showing the schematic constitution of a composite electronic component based on a third embodiment of the present invention. Referring to Figure 7, with the composite electronic component pertaining to this embodiment, thick-film laminate 25, on which an inductor 23 of silver (Ag) or silver palladium (AgPd) is formed in a circumferential form using screen printing on magnetic substrate 21A of an Ni-Zn ferrite, is fired. Then a thin-film capacitance part 27 is additionally furnished on top of that, and terminal electrodes 31 and 31 are formed at both ends of the chip coated with heat-resistant resin 29.

[0049]

Figure 8 is a cross section schematically showing the constitution of the composite electronic component shown in Figure 7.

[0050]

Thin-film capacitance part 27 has capacitive element 36 wherein capacitor internal electrodes 33 and 33, of Cu, and dielectric layer 35, of polyimide, are laminated, as shown in Figure 8. Here, the constitution of terminal electrodes 31 and 31 is the same as terminal electrodes 11 and 11 in the first embodiment described above.

[0051]

With the composite electronic component pertaining to this embodiment, a composite electronic component that is small and inexpensive and that includes an inductor that has a relatively large L value can be provided.

[0052]

Here, with the above embodiment, an inductor 23 was furnished for thick-film laminate 25, but a transformer could also be formed in place of the inductor. And a resistor layer could of course also be formed, in addition to capacitive element 36, in thin-film capacitance part 27.

[0053]

Next, a composite electronic component pertaining to a fourth embodiment of the present invention will be explained.

[0054]

The composite electronic component pertaining to the fourth embodiment is approximately the same as the third embodiment shown in Figure 7. With the composite electronic component in the fourth embodiment, the distinctive feature is that benzocyclobutene (BCB) resin is used for dielectric layer 35 of thin-film capacitance part 27. Terminal electrodes using a conductive resin and a plated electrode are also used in place of terminal electrodes 31 and 31 in the third embodiment shown in Figure 7, just as in the second embodiment shown in Figure 6.

[0055]

First, to construct thin-film capacitance part 27 in the fourth embodiment, capacitor internal electrodes 33 and 33 of Cu are formed with approximately the same process as the process for forming conductor pattern 12 shown in Figures 3 and 4.

[0056]

Dielectric layer 35 is also formed with approximately the same process as the process for forming insulating resin layer 15 shown in Figure 5.

[0057]

With the composite electronic component pertaining to this embodiment, because BCB resin is used for conductor layer 35 of thin-film capacitance part 27, smoothing of unevenness in the conductive pattern produced by the dielectric layer is extremely good, and because of this, there is no rippling in the conductive pattern laminated on top, and a conductive pattern with high dimensional precision can be formed. And because there is no rippling in the conductive pattern, thin-film capacitance part 27 can be made even thinner by that amount, compared to the third embodiment above. In addition, because a conductive pattern with high dimensional precision and with no rippling in the conductive pattern can be formed, misalignment will not occur between capacitor internal electrodes 33 and 33 on the two sides of dielectric layer 35, and the precision of capacitor 36 can be increased.

[0058]

In addition, because BCB resin, with which there is no concern over Cu migration, is used, a Cu pattern that has low resistance, that can be electrolytically plated, and with which wet etching is also easy, can be selected for the conductive pattern, and a low-cost composite electronic component can be provided.

[0059]

Effect of the invention

As explained above, with the invention described in Claim 1, a composite electronic element can be provided that has both a high-capacity capacitive element and an inductor with a highly precise L value, as well as being small and inexpensive.

[0060]

With the invention described in Claim 2, because BCB resin is used for the aforementioned insulator layer, an inductor with an even more highly precise L value can be furnished. In addition, because BCB resin is used, a Cu pattern that has low resistance, that can be electrolytically plated, and with which wet etching is also easy, can be selected for the conductive pattern, and a low-cost composite electronic component can be provided. Therefore, a small, thin composite electronic component that has both a large-capacitance capacitive element and an inductor with a highly precise L value can be provided at low cost.

[0061]

In addition, with the inventions described in Claim 3 or 4, a composite electronic component without a problem of environmental pollution during manufacture, as well as having both a large-capacitance capacitive element and an inductor with a highly precise L value, can be provided.

[0062]

With the invention described in Claim 5, a small, inexpensive composite electronic component that includes an inductor with a relatively large L value can be provided.

[0063]

With the invention described in Claim 6, because BCB resin is used for the aforementioned dielectric layer, a small, thin composite electronic component that has an inductor with a relatively large L value can be provided at low cost.

[0064]

In addition, with the invention described in Claim 7 or 8, a composite electronic component without a problem of environmental pollution during manufacture, as well as including an inductor with a relatively large L value, can be provided.

Brief description of the figures

Figure 1 is a schematic diagram showing a composite electronic component based on a first embodiment of the present invention.

Figure 2 shows the constitution of the composite electronic component shown in Figure 1.

Figures 3(a), (b), (c) and (d) are cross sections sequentially showing processes for forming the conductor layer of the thin-film coil part of the composite electronic component shown in Figure 1.

Figures 4(a), (b), (c) and (d) are cross sections sequentially showing processes for forming the conductor layer of the thin-film coil part of the composite electronic component shown in Figure 1.

Figures 5(a), (b), (c) and (d) are cross sections sequentially showing processes for forming the insulating layer of the thin-film coil part of the composite electronic component shown in Figure 1.

Figure 6 is provided to explain the method of forming terminal electrodes on the electronic component in Figure 1.

Figure 7 is a schematic diagram showing a composite electronic component based on a third embodiment of the present invention.

Figure 8 shows the constitution of the composite electronic component shown in Figure 7.

Figure 9 shows a composite electronic composite that uses a conventional thick-film laminated structure and wherein a capacitor and inductor are embedded in a ferroelectric ceramic.

Figure 10 shows a composite electronic component wherein a thick-film laminate in which an inductor is embedded in a nonmagnetic, non-ferroelectric ceramic is stacked on top of a thick-film laminate of a ferroelectric ceramic in which a conventional capacitive element is embedded.

Explanation of symbols

1A Ferroelectric ceramic substrate
2 Conductive pattern
3 Capacitive element
5 Thick-film laminate
7 Thin-film coil part
9 Heat-resistant resin
11 Terminal electrode
11A Terminal foundation electrode
11B Ni layer
11C Solder layer
13 Thin-film coil
15 Insulating resin layer
21A Magnetic substrate
22 Conductive pattern
23 Inductor
25 Thick-film laminate
27 Thin-film capacitance part
29 Heat-resistant resin
31 Terminal electrode
33 Capacitor internal electrode
35 Dielectric layer
36 Capacitive element

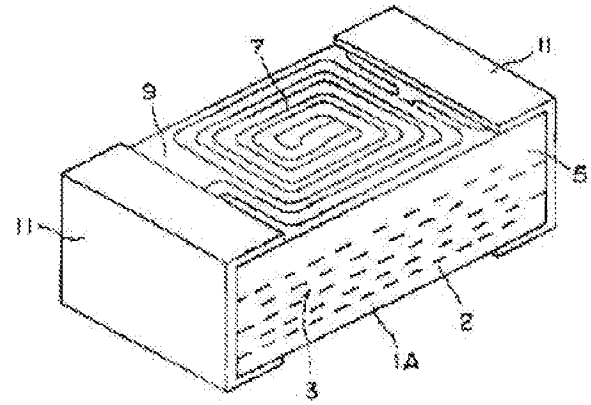


Figure 1

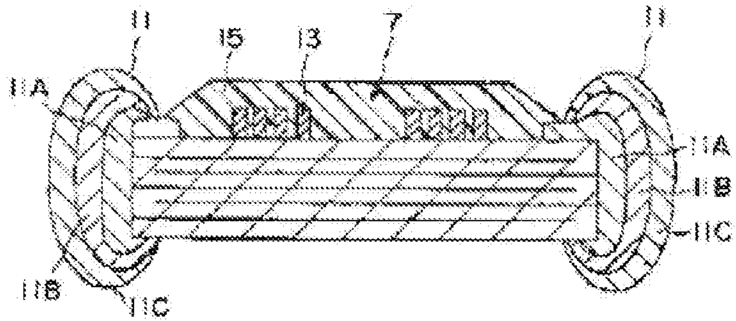


Figure 2

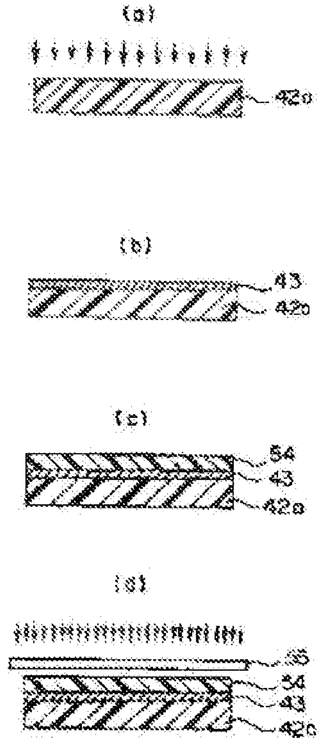


Figure 3

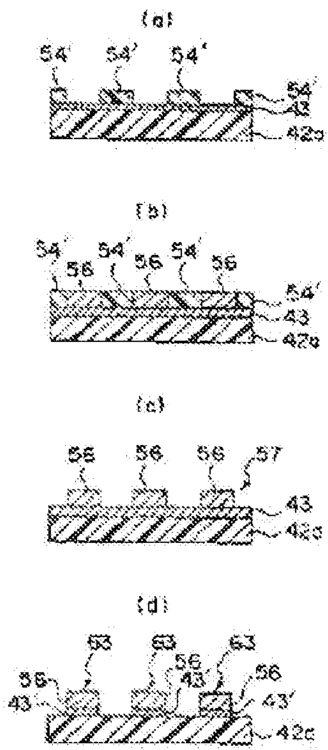


Figure 4

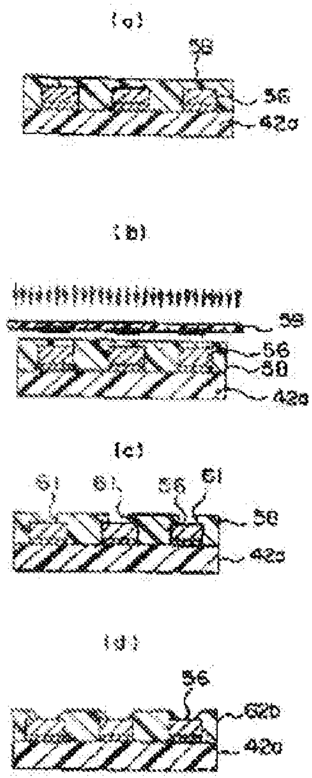


Figure 5

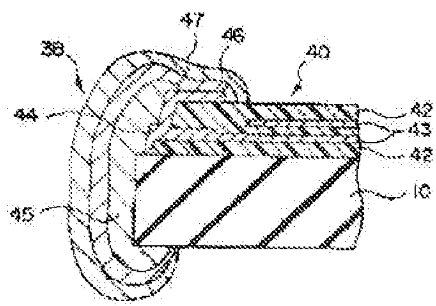


Figure 6

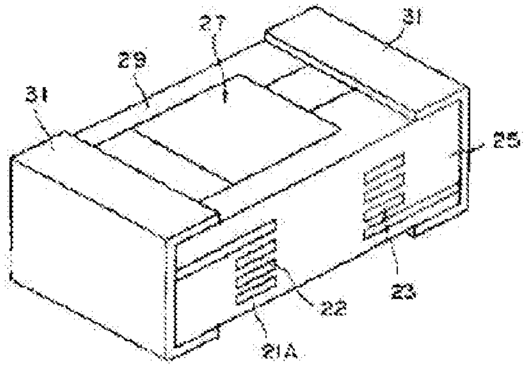


Figure 7

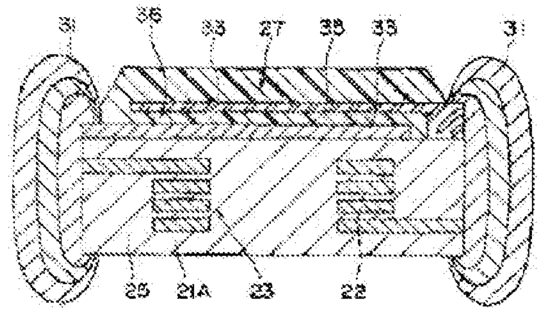


Figure 8

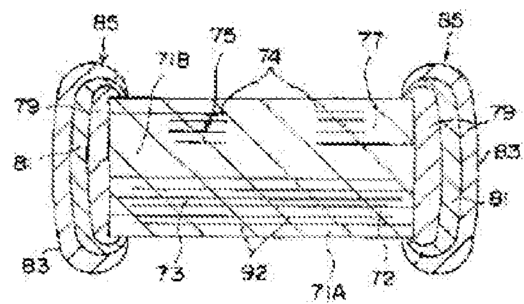


Figure 9

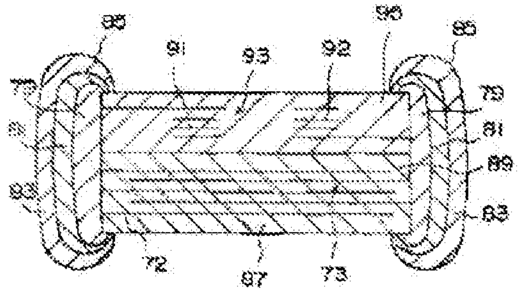


Figure 10